**WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care**

**Worksheet author(s)**
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**Date Submitted for review:** February 4th, 2010

**Clinical question.**
In pregnant patients with cardiac arrest (prehospital or in-hospital) (P), do any specific interventions (I) as opposed to standard care (according to treatment algorithm) (C), improve outcome (O) (eg. ROSC, survival)?

This question is addressing an intervention/therapy  
This is a proposed new topic

**Conflict of interest specific to this question**
None

**Search strategy (including electronic databases searched).**

### Out of Hospital Arrest

- EMBASE 1980 to 2008 Week 49
- Ovid MEDLINE(R) 1996 to November Week 3 2008

**Searches Results**

**EMBASE 1980 to 2008 Week 49**
1 exp Pregnancy/ 178182  
2 exp Pregnant Woman/ 4385  
3 exp Heart Arrest/ 15696  
4 out-of-hospital.mp. 2906  
5 pre-hospital.mp. 1047  
6 prehospital.mp. 3886  
7 (1 or 2) and 3 and (4 or 5 or 6) 5  
8 from 7 keep 1-5 5  
Results of your search: from 7 [(1 or 2) and 3 and (7 or 9 or 11)] keep 1-5  
Results Available: 5

**Ovid MEDLINE(R) 1996 to November Week 3 2008**

1 exp Pregnancy/ or Pregnancy Complications, Cardiovascular/204977  
2 exp Pregnant Women/1399  
3 exp Heart Arrest/12544  
4 1 or 2205107  
54 and 3193  
6 exp Emergencies/10234  
7 exp Emergency Medical Services/38481  
8 exp Emergency Treatment/33525  
98 or 6 or 774589  
109 and 571  
11 from 10 keep 10, 47, 58, 694  
125193  
13 limit 12 to humans189  
14 from 11 keep 1-44  
15 from 14 keep 1-44  
Results of your search: from 14 [from 11 keep 1-4] keep 1-4  
Results Available: 4

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All EBM Reviews - Cochrane DSR, ACP Journal Club, DARE, CCTR, CMR, HTA, and NHSEED

**Searches Results**

1 pregnant.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 19343  
2 cardiac arrest.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 873  
3 heart arrest.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 964  
4 out-of-hospital.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 34458  
5 pre-hospital.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 163  
6 prehospital.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 406  
7 1 and (2 or 3) and (4 or 5 or 6) 36  
8 from 7 keep 1-36 36  
Results of your search: from 7 [1 and (2 or 3) and (4 or 5 or 6)] keep 1-36  
Results Available: 36

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Ovid MEDLINE(R) 1996 to November Week 3 2008

**Searches Results**
1 exp Pregnancy/ 204977
2 exp Pregnant Women/ 1399
3 exp Heart Arrest/ 12544
4 out-of-hospital.mp. 2150
5 pre-hospital.mp. 882
6 prehospital.mp. 2893
7 (1 or 2) and 3 and (4 or 5 or 6) 2
8 from 7 keep 1-2 2
Results of your search: from 7 [(1 or 2) and 3 and (4 or 5 or 6)] keep 1-2
Results Available: 2

In Hospital Arrest:

EMBASE 1980 to 2008 Week 49
# Searches Results
1 exp Pregnancy/ 178182
2 exp Pregnant Woman/ 4385
3 exp Heart Arrest/ 15696
4 inhospital.mp. 770
5 in-hospital.mp. 26654
6 exp Hospital/ 145400
7 (1 or 2) and 3 and (4 or 5 or 6) 10
8 from 7 keep 1-10 10
Results of your search: from 7 [(1 or 2) and 3 and (4 or 5 or 7)] keep 1-10
Results Available: 10

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 exp Pregnancy/ 204977
2 exp Pregnancy Complications/ 98633
3 exp Heart Arrest/ 12544
4 1 or 3 or 2 213151
5 limit 5 to humans 11590
6 76 and 4203
7 exp *Heart Arrest/ 8184
8 from 7 keep 1, 3-5, 7-9, 13, 169
9 104 and 99
10 118 and 4129
11 12 from 11 keep 1-129129
12 13 from 11 keep 1-129129
13 14 from 13 keep 1-129129
14 15 from 14 keep 1-4, 6, 9-11, 13-15, 17-19, 23-25...65
8 from 7 keep 1-129 129
10 from 129 keep 1-129 129
12 from 13 keep 1-129 129
14 from 13 keep 1-129 129
15 from 14 keep 1-4, 6, 9-11, 13-15, 17-19, 23-25...65
Results of your search: from 14 [from 13 keep 1-129] keep 1-4, 6, 9-11, 13-15, 17-19, 23-25...
Results Available: 65

All EBM Reviews - Cochrane DSR, ACP Journal Club, DARE, CCTR, CMR, HTA, and NHSEED
# Searches Results
1 pregnant.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 19343
2 cardiac arrest.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 873
3 heart arrest.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 964
4 inhospital.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 95
5 in-hospital.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 35140
6 1 and (2 or 3) and (4 or 5) 36
7 8 from 6 keep 1-36 36
Results of your search: from 6 [1 and (2 or 3) and (4 or 5)] keep 1-36
Results Available: 36

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 exp Pregnancy/ 204977
2 exp Pregnant Women/ 1399
3 exp Heart Arrest/ 12544
4 inhospital.mp. 426
5 in-hospital.mp. 19601
6 exp Hospitals/ 60482
7 (1 or 2) and 3 and (4 or 5 or 6) 1
8 from 7 keep 1 1
Results of your search: from 7 [(1 or 2) and3 and (4 or 5 or 6)] keep 1
Results Available: 1

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 exp Heart Arrest/ rt, dl, dt, pc, su, mo, rh, th [Radiotherapy, Diet Therapy, Drug Therapy, Prevention & Control, Surgery, Mortality, Rehabilitation, Therapy] 6516
2 exp Heart Arrest/ 12544
3 *Pregnancy/ 6873
4 exp Pregnant Women/ 1399
5 3 or 4 8136
6 exp "Outcome Assessment (Health Care)"/ 356114
7 6 and 2 and 5 0
8 exp Survival/ 1818
9 8 and 2 and 5 0
10 return of spontaneous circulation.mp. 466
11 10 and 2 and 5 0
12 2 and 5 0
13 exp Pregnancy/ 204977
14 4 or 13 205107
15 2 and 14 193
16 8 or 6 or 10 357995
17 16 and 1510 0
18 from 17 keep 1-10 10

Pregnancy and Cardiovascular Physiology:
EMBASE 1980 to 2008 Week 49
# Searches Results
1 exp Pregnancy/ 178182
2 exp Heart Output/ 20824
3 exp Heart Arrest/ 15696
4 1 and 2 and 3 7
5 from 4 keep 1-7 7
Results of your search: from 4 [1 and 2 and 3] keep 1-7
Results Available: 7

EMBASE 1980 to 2008 Week 49
# Searches Results
1 exp Pregnancy/ 178182
2 exp Cardiovascular System/ 668403
3 exp Heart Arrest/ 15696
4 3 and 2 and 1 35
5 from 4 keep 1-35 35
Results of your search: from 4 [6 and 4 and 1] keep 1-35
Results Available: 35

EMBASE 1980 to 2008 Week 50
# Searches Results
1 exp Pregnancy/ 178344
2 exp Pregnant Woman/ 4428
3 exp hemodynamics/ 354020
4 exp Heart Arrest/ 15707
5 (1 or 2) and 3 and 4 23
6 from 5 keep 1-23 23
Results of your search: from 5 [(1 or 2) and 3 and 4] keep 1-23
Results Available: 23

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 exp *Pregnancy/ 37043
2 exp *Cardiac Output/ 3525
32 and 1 18
4 from 3 keep 1-18 18
Results of your search: from 3 [6 and 1] keep 1-18
Results Available: 18

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 exp *Pregnancy/ 37043
2 exp *Cardiovascular System/ 197478
3 exp Pregnancy Complications, Cardiovascular/ 4266
4 3 and 1 and 2 36
5 from 4 keep 1-36 36
Results of your search: from 4 [4 and 1 and 2] keep 1-36
Results Available: 36

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 exp *Pregnancy/ 37043
2 exp *Hemodynamics/ 61402
3 hemodynamic changes.mp. 2709
4 1 and (2 or 3) 661
5 exp Pregnancy Complications, Cardiovascular/ 4266
6 5 and 4 34
7 limit 6 to humans 28
8 from 7 keep 1-28 28
Results of your search: from 7 [limit 6 to humans] keep 1-28
Results Available: 28

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 exp Heart Arrest/ 12544
2 exp Pregnancy/ 204977
3 exp Pregnant Women/ 1399
4 maternal cardiac output.mp. 18
5 Cardiac Output/ 6608
6 exp Blood Pressure/ 69404
7 Posture/ or left lateral position.mp. 17005
8 1 and (2 or 3) and (4 or 5 or 6) and 7 0
9 (2 or 3) and (4 or 5 or 6) and 7 37
10 from 9 keep 1-37 37
Results of your search: from 9 [(2 or 3) and (4 or 5 or 6) and 7] keep 1-37
Results Available: 37

Pregnancy and Respiratory Physiology:

All EBM Reviews - Cochrane DSR, ACP Journal Club, DARE, CCTR, CMR, HTA, and NHSEED
# Searches Results
1 pregnancy.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 19343
2 airway.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 7877
3 1 and 2 56
4 pulmonary function.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 3020
5 pulmonary physiology.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 10
6 1 and (4 or 5) 36
7 Cardiovascular changes.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 231
8 7 and 1 13
9 cardiac output.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 3445
10 1 and 9 67
11 hemodynamic changes.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 738
12 1 and 11 20
13 left lateral position.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 57
14 posture.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 3076
15 1 and (9 or 12) and (13 or 14) 6
16 6 or 8 or 3 or 10 or 12 or 15 171
17 cardiac arrest.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 873
18 heart arrest.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 964
19 16 and (17 or 18) 3
20 from 19 keep 1-3 3
Results of your search: from 19 [16 and (17 or 18)] keep 1-3
EMBASE 1980 to 2008 Week 49
# Searches Results
1 exp Pregnancy/ 178182
2 exp Pregnant Woman/ 4385
3 exp Heart Arrest/ 15696
4 exp Airway/ 7663
5 exp Respiratory System/ 267626
6 exp Respiratory Function/ 131480
7 exp Breathing Mechanics/ 4535
8 (1 or 2) and 3 and (4 or 5 or 6 or 7) 19
9 from 8 keep 1-19 19
Results of your search: from 8 [(1 or 2) and 3 and (4 or 5 or 6 or 7)] keep 1-19
Results Available: 19

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 airway.mp. 45866
2 Respiratory System/ or Respiratory Physiologic Phenomena/ or Respiratory Physiology/ or Respiratory Mechanics/ 12356
3 exp Pregnancy/ 204977
4 exp Pregnant Women/ 1399
5 exp Heart Arrest/ 12544
6 (1 or 2) and (3 or 4) and 5 9
7 exp Pregnancy Complications, Cardiovascular/ 4266
8 (1 or 2) and (3 or 4) and 6 9
9 6 or 8 9
10 from 9 keep 1-9 9
Results of your search: from 9 [6 or 9] keep 1-9
Results Available: 9

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 exp Pregnancy/ 204977
2 exp Pregnancy Complications/ 98633
3 exp Lung/pp [Physiopathology] 5516
4 exp Respiratory Function Tests/ 62246
5 exp Respiration Disorders/ or Respiration/ 60226
6 exp Pregnant Women/ 1399
7 6 or 1205107
8 3 and 7111
9 limit 8 to humans 68
10 from 9 keep 8, 56, 633
114 and 71119
12 exp *Respiratory Function Tests/ 17115
137 and 12304
14 limit 13 to humans 267
15 from 14 keep 8, 41, 43, 53, 67, 73...15
1610 or 1518
17 from 16 keep 1-1818
Results of your search: from 16 [10 or 15] keep 1-18
Results Available: 18

Fetal Survival:
All EBM Reviews - Cochrane DSR, ACP Journal Club, DARE, CCTR, CMR, HTA, and NHSEED
# Searches Results
1 maternal cardiac arrest.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 1
2 pregnancy.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 19343
3 cardiac arrest.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 873
4 heart arrest.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 964
5 fetal outcomes.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 244
6 fetal survival.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 13
7 fetal.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 5715
8 infants.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 26885
9 (1 or (2 and (3 or 4))) and (5 or 6 or 7 or 8) 21
10 from 9 keep 1-21 21
Results of your search: from 9 [(1 or (2 and (3 or 4))) and (5 or 6 or 7 or 8)] keep 1-21
Results Available: 21

EMBASE 1980 to 2008 Week 50
#Searches Results
1 exp Pregnancy/ 178344
2 exp Pregnant Woman/ 4428
3 exp fetus outcome/ or exp pregnancy outcome/ 7800
4 fetal survival.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name] 698
5Fetus/ 100358
6 exp Heart Arrest/ 15707
7 (1 or 2) and (3 or 4 or 5) and 6 25
8 from 7 keep 1-25 25
Results of your search: from 7 [(1 or 2) and (3 or 4 or 5) and 6] keep 1-25
Results Available: 25

Ovid MEDLINE(R) 1996 to November Week 3 2008
#Searches Results
1 exp Heart Arrest/ 12544
2 exp Pregnancy/ or exp Pregnancy Complications, Cardiovascular/ 204977
3 exp Pregnancy Outcome/ 20578
4 fetal outcomes.mp. 1250
5 fetal survivors.mp. [mp=title, original title, abstract, name of substance word, subject heading word] 404
6exp Fetus/ 37367
7 1 and 2 and (3 or 4 or 5 or 6) 28
8 from 7 keep 1-28 28
Results of your search: from 7 [1 and 2 and (3 or 4 or 5 or 6)] keep 1-28
Results Available: 28

Pharmacokinetics in Pregnancy:

All EBM Reviews - Cochrane DSR, ACP Journal Club, DARE, CCTR, CMR, HTA, and NHSEED
# Searches Results
1 pregnant.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 19343
2 pharmacokinetics.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 16323
3 resuscitation.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 1427
4 drug*.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 165593
5 1 and 2 and 3 and 4 2
6 1 and 2 180
7 "Pregnancy".kw. 1826
8 pharmacokinetics.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] 12932
9 8 and 7 26
10 from 9 keep 1-26 26

Ovid MEDLINE(R) 1996 to November Week 3 2008
# Searches Results
1 exp Pregnancy/ 204977
2 exp Resuscitation/ 25069
3 resuscitation drugs.mp. 11
4 pharmacokinetic changes.mp. 192
5 exp pharmacokinetics/ 75082
6 1 and (2 or 3) and (4 or 5) 0
7 1 and 5 1676
8 1 and 2 and 5 0
9 exp *Pregnancy/ 37043
10 exp *Pharmacokinetics/ 3113
11 10 and 9 13
12 from 11 keep 1-13 13

EMBASE 1980 to 2009 Week 02
# Searches Results
1 exp *Pharmacokinetics/ 123362
2 exp *Pregnancy/ 63934
3 1 and 2 855
Results of your search: from 9 [8 and 3] keep 1-16

Other sources:

* Position statement from the Canadian Association of Emergency Physicians, and below, a list of links to various resources:
* http://circ.ahajournals.org/cgi/reprint/112/24_suppl/IV-150 (article from Circulation)
* http://www.alsg.org/fileadmin/_temp_/Specific/MOET_specific/ILCOR/Chapter_3__CPR.pdf (Advanced Life Support Group, Chapter 3: Cardiopulmonary resuscitation in the non-pregnant and pregnant patient)
* http://www.mdconsult.com/das/search/summaryresults/111766762-2?search_id=777250317&kw=cardiac%20arrest%20AND%20pregnancy&search_type=Summary&etype=All&bbSortBy=hits (search results from MD Consult)
* UpToDate is an evidence based, peer reviewed information resource - available via the Web, desktop, and PDA. With UpToDate, you can answer questions quickly, increase your clinical knowledge, and improve patient care. Independent studies confirm these benefits. The UpToDate community includes our faculty of more than 3,800 leading physicians, peer reviewers, and editors and over 340,000 users. Our faculty writes topic reviews that include a synthesis of the literature, the latest evidence, and specific recommendations for patient care. Our users provide feedback to the editorial group. This community's combined efforts result in the most trusted, unbiased medical information available.

* we searched the bibliographies of all selected articles to ensure the search strategy was comprehensive
* We included an article based on expert recommendation which was not captured in the search strategy (Kundra et al). Based on the article by Kundra et al, we found 1 further article from a hand search of the bibliography (Amaro et al) and a second additional article from review of the literature based on a specific search strategy on manual displacement of the uterus (Cyna etal.).

* the search strategy was re-run in November 2009, no other studies were identified.

ECC Endnote Master library:

Search strategy: Pregnancy: 411 References found

• State inclusion and exclusion criteria

Inclusion Criteria:
Pregnancy and cardiac arrest out of hospital,
Pregnancy and cardiac arrest in hospital
Cardiovascular physiology and pregnancy as it relates to cardiac arrest and resuscitation
Respiratory physiology and pregnancy as it relates to cardiac arrest and resuscitation
Fetal survival as it relates to cardiac arrest
Pharmacokinetics in pregnancy

Exclusion criteria:
Non-cardiac arrest topics
Non-pregnancy topics
Review articles
Articles not available in English.

• Number of articles/sources meeting criteria for further review:

22 references found meeting criteria for further review
### Summary of evidence

#### Evidence Supporting Clinical Question

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<th>Fair</th>
<th>Poor</th>
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<tr>
<td></td>
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<td>Rees (2002) E1</td>
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<td>Rittenberger (2008) E5</td>
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1 2 3 4 5

#### Level of evidence

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  

E = Other endpoint:  
**Italics** = Animal studies

**E1:** Importance of appropriate aortocaval decompression  
**E2:** Respiratory changes in pregnancy.  
**E3:** Perimortem cesarean section  
**E4:** Changes in pharmacokinetics  
**E5:** Resuscitation technique
Evidence Neutral to Clinical question

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<td>Nanson (2001) E5</td>
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**Level of evidence**

A = Return of spontaneous circulation  
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D = Intact neurological survival  
E = Other endpoint  
*Italic* = Animal studies

E1: Importance of appropriate aortocaval decompression  
E2: Respiratory changes in pregnancy  
E3: Perimortem cesarean section  
E4: Changes in pharmacokinetics  
E5: Resuscitation technique

Evidence Opposing Clinical Question

<table>
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<td>Poor</td>
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<td>Matorras (1998) E1</td>
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</table>

| 1 | 2 | 3 | 4 | 5 |

**Level of evidence**

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E = Other endpoint  
*Italic* = Animal studies

E1: Importance of appropriate aortocaval decompression  
E2: Respiratory changes in pregnancy  
E3: Perimortem cesarean section  
E4: Changes in pharmacokinetics  
E5: Resuscitation technique
DISCUSSION: Resuscitation of a pregnant woman who has a cardiac arrest is a challenging situation. There are two patients to consider, the mother and the fetus. We know there are several differences in the physiology of pregnancy that in theory should change the way in which we resuscitate these women. However, there have been no trials specifically done to evaluate different resuscitation techniques versus standard care and outcomes for cardiac arrest in pregnancy. Therefore, we chose to examine the science behind the individual aspects of important physiologic changes that occur in pregnancy which may impact recommendations and guidelines for resuscitation of cardiac arrest in pregnancy.

The science behind even these different physiologic changes is very weak. For example, we know there are pharmacokinetic changes in pregnancy; however, no studies have been done specifically on medications used during resuscitation. There are many changes in pulmonary physiology, however, there are no studies specifically looking at the best method of airway management in resuscitation of the unstable pregnant patient. The evidence to support the use of left lateral tilt during maternal cardiac arrest is extrapolated from cesarean section data.

The number of studies which specifically addresses maternal resuscitation issues was 5. Two of these studies examined performing chest compressions in a left lateral tilt position. These 2 studies found that although chest compressions can be done in the left lateral position, the resuscitative force will be increasingly compromised relative to increasing degrees of tilt. The third study observed that the transthoracic impedance is not altered significantly during pregnancy and therefore concluded that current energy requirements for adult defibrillation are appropriate for use during pregnancy. The fourth study was a systematic review of perimortem cesarean section. There are no randomized trials looking at the benefit of perimortem cesarean section, and the case reports are varied in the clinical scenarios. However, one of the aims of this systematic review was to examine the effects of cesarean section on cardiopulmonary resuscitation success. Twenty-two of the 38 case reports provided enough information regarding the effects of the cesarean section on maternal hemodynamic status. Twelve women were reported to have a sudden and often dramatic improvement in their clinical status, including a return of the pulse and blood pressure, immediately after the uterus was emptied. Four infants were born >15 minutes after the onset of maternal cardiac arrest. These infants were 30-38 weeks gestational age and were born without adverse outcomes. There were no reports of the maternal hemodynamic status deteriorating post emergency cesarean section. There was one retrospective cohort study of perimortem cesarean section which reported an increase in the use of perimortem cesarean section (PMCS) after the introduction of a training program on its use. The number of PMSC that were performed within the recommended 5 minute time frame after the onset of maternal cardiac arrest was 0. Cardiac output returned in 67% of mothers after PMSC. Maternal case fatality rate was 83%. Neonatal case fatality rate was 58%.

We know from the studies presented that aortocaval compression does negatively affect the hemodynamics and status of both the mother and fetus. Given the effect of aortocaval compression on reducing preload we can extrapolate that relieving aortocaval compression during a maternal cardiac arrest would probably be important to help assist in the resuscitation efforts. Previous recommendations on the management of cardiac arrest associated with pregnancy have described using the left lateral tilt to achieve this objective. However, left lateral tilt is passively trying to use gravity to help reduce maternal vessel compression by the uterus and its affect may not be complete. In addition, the recommendations to tilt a patient while performing chest compressions does not take into account Emergency Cardiovascular Care science (ECC). We know that chest compressions act to induce pressure changes in the thoracic cavity which help the heart maintain its pump function. There is only evidence of chest compression effectiveness in the supine position. Other then a few case reports of successful use of chest compressions in the prone position, there is no data on the effectiveness of chest compressions in any other position. Therefore, there is no hemodynamic data on chest compressions done in the left lateral tilt position. There is no evidence on whether or not chest compressions done in the left lateral position will result in the heart maintaining its pump function and hence whether left lateral tilt chest compressions will result in systemic blood flow and maintenance of coronary and cerebral perfusion.

In addition ECC science acknowledges that the most effective way to resuscitate a patient from a pulseless arrest includes performing high quality chest compression. Important aspects of high quality chest compressions include: performing chest compressions in the supine position, maintaining adequate force during chest compressions, minimizing interruptions in chest compressions, and performing chest compressions on a firm surface. All of these aspects could be negatively affected during left lateral tilt. During left lateral tilt the patient would not be supine, left lateral tilt chest compressions have been shown to be less forceful, the duration of time spent to tilt a pregnant patient may result in an suboptimal interruption in chest compressions, and the surface onto which the patient is tilted may not be firm. All of these aspects could negatively impact on the cerebral and coronary perfusion pressure. Therefore, we believe that the best manner to resuscitate a pregnant patient in cardiac arrest is to attempt to maintain the features of ECC science that are known to be important to achieving success, including high quality chest compressions in the supine position with minimal interruptions, however utilize the supine active manual left displacement of the uterus to relieve aortocaval compression. Manual left uterine displacement (LUD) has been found to be at least the same and if not more effective than left lateral tilt in relieving aortocaval compression in a cesarean section population. However, even with LUD
and lateral tilt caregivers may not be able to completely relieve the aortocaval compression enough for resuscitation purposes and therefore return of spontaneous circulation (ROSC) may never occur with a gravid uterus. In this situation, when after a maximum of 4 minutes of resuscitation efforts there is no ROSC, caregivers should decide on whether or not to perform a perimortem cesarean section. Perimortem cesarean section should be viewed as one treatment option during maternal resuscitation efforts in an attempt to achieve ROSC.

There is one case report looking at post resuscitative care in pregnancy successfully using hypothermia. Both the maternal and fetal outcome was favorable, however, maternal hypothermia resulted in fetal bradycardia that resolved with re-warming and was not hemodynamically significant to the fetus.

The recommendations based on science will be few which reflect the lack of evidence in this area. The need for further studies is great. However, despite the lack of science, if a pregnant woman has a cardiac arrest the medical personnel caring for the patient will need direction and recommendations on how to best treat the patient. There have been previous recommendations and reviews written on the optimal resuscitation techniques and important factors to consider for cardiac arrest in pregnancy. However, the knowledge and implementation of these recommendations has been found to be poor. In addition, we believe that the recommendation to tilt pregnant women in cardiac arrest is not the most ideal method of resuscitation. Performing chest compressions supine with left manual displacement of the uterus maybe the most effective technique to both relieve aortocaval compression and maintain high quality chest compressions.

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Citation List

   Level 5 (not related). E1 supportive. Fair. This study found that a proportion of patients have adverse changes to the fetal heart rate when the mother is in the supine position. A proportion of these patients were observed to have normalization of the fetal heart rate (FHR) once the mother was turned left lateral. In addition they found that the supine position and abnormal FHR was associated with fetal acidosis and this normalized with the left lateral position. This study also found that in the supine position (compared to the left lateral position), during uterine contractions there was a significant fall in the lower limb blood pressure by a mean of 5.4 mmHg (89% drop). There was no drop in the upper limb blood pressure. This study illustrates that aortic compression by the uterus occurs in the supine position especially during uterine contractions. And that the fetal distress demonstrated in this study in the supine position was believed to be related to aortic compression. Fetal scalp pH studies confirmed acidosis in the supine position that resolved in the left lateral position.

   Level 5 (not related). E3 supportive. Good. This study found that at 22 weeks gestational age there was no fetal viability after birth, the best outcome was seen when the infants were born at 25 weeks gestational age, and birth between 23-24 weeks gestational had increased incidence of morbidity and mortality of the infant compared with birth at 25 weeks gestational age.

   Level 5 (not directly relates), E1, supportive. Randomized, small study. This randomized trial of 40 women undergoing elective cesarean section found there was no difference in hypotension between the Crawford’s wedge (which provides 15º left lateral tilt) and the manual uterine displacement groups. The neonates in this trial were found to have apgars of 8 or more, with no difference in umbilical artery pH.


Level 5 (not directly related). E2 Supportive. Good. Non-Randomized. The physiological changes of pregnancy predispose these patients to a narrower airway. There is weight gain, decrease in functional residual capacity, pharyngeal edema, and possibly the effect of sleep deprivation. This was the first study to measure the upper airway in the third trimester of pregnancy. This study documented that the upper airway in pregnant patients is significantly narrower compared to non-pregnant patients and the post-partum period. On lying down, the oropharyngeal junction narrowed more markedly during pregnancy. This study controlled for age, weight, familial factors and sleep state.


Level 5 (not related). E1. Supportive. Poor. Small sample size. The degree of tilt was observed to be overestimated. 10/16 anesthetists overestimated the degree of tilt by 10°.


Level 5 (not related). E3 supportive. Good study. This study found that 17/24 infants survived after a perimortem cesarean section. 8/17 were delivered within 5 minutes of the maternal cardiac arrest, of those 4 were normal infants. Of note 4/7 infants born > 15 minutes after maternal cardiac arrest were also normal infants; however these infants tended to be older at 30-38 weeks gestational age. 12/20 patients were noted to have a sudden and often profound improvement in the maternal hemodynamic status, including return of pulse and blood pressure at the time the uterus was emptied. Of the 8/20 that did not, the mother had suffered lethal injury.


Level 5 (not related) E1 Supportive. Good study. This study found that aortocaval decompression can be achieved more effectively than placing the patient in a left lateral tilt by performing manual displacement of the uterus. This provides health care workers a mode of relieving aortocaval compression while maintaining the patient in a supine position.


Level 5 (not directly related), E1 Opposed. Good. Randomized. Good discussion about the importance of preventing aortic compression. Negative study probably because the surgical time was short (average was 12.62 minutes) and hypotension was prevented. But the points illustrated and discussed are important for resuscitation.


Level 5 (not related). E1. Supportive. Good. This study observed improved maternal hemodynamic stability when the patient was placed in the full left lateral position versus a 12° left lateral tilt from the horizontal after CSE anesthesia.


Level 5 (not related). E5. Neutral. Fair. Small sample size. This study observed that the transthoracic impedance is not altered significantly during pregnancy


Level 5 study (not directly related), E1 Supportive. Good study. Randomized. This study observed a significant difference in leg blood pressures between groups and therefore even at a 15° left lateral tilt there is evidence of compression of the aorta which was not evident based on arm blood pressure readings.

Level 5 (not related). E5 Supportive. Poor. Small sample size. At a left lateral tilt angle of 27º the responders will be able to achieve 80% of the maximum resuscitative force of chest compressions compared with the supine position, without the patient sliding or rolling off the incline plane.


Level 5 (related). E5. Supportive. Poor. This was the only case report in the literature that has demonstrated that post-cardiac arrest in pregnancy maternal hypothermia can be used both safely and effectively with a favorable maternal and fetal outcome. However, maternal hypothermia can be associated with fetal bradycardia.


Level 5 (not directly related). E1 Supportive. Good. This study found that when mothers are were turned onto the left lateral position the non-stress test of the fetus significantly improved. The number of acceleration increased, overall variation and short-term variation increased, while basal heart rate decreased. The change in position was associated with an increase in maternal stroke volume. And the NST correlated with hemodynamic parameters.


Level 5 study (not directly related). E4 Supportive. Poor. Small sample size. This study observed that there is an increase in glomerular filtration rate and plasma volume during normal pregnancy.